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U.S. Marine Corps Summer 1994 Mapping, Charting, and Geodesy Systems Requirements Evaluation

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U.S. MARINE CORPS SUMMER 1994 MAPPING, CHARTING, AND GEODESY SYSTEMS REQUIREMENTS EVALUATION

1.0 BACKGROUND

This report presents an analysis of the initial Marine Corps Requirements Analysis survey conducted by the Digital Mapping, Charting, and Geodesy (MC&G) Analysis Program (DMAP) staff during summer, 1994. [Ed. Note: The data presented in this report were current during summer, 1994. Some U.S. Marine Corps (USMC) systems have come online since that time and are not included here. It should be noted that the points of contact used during 1994 have also changed.]

The USMC initiated this effort with the Naval Research Laboratory (NRL) Digital Mapping, Charting, and Geodesy Analysis Program to provide a review of MC&G usage in key Marine Corps programs. This review provides: (1) recommended improvements to Marine Corps usage of MC&G, (2) requirements to improve MC&G product reviews for the Marine Corps, and (3) additional overview information for improved policymaking decisions on MC&G for the Marine Corps.

1.1 Approach

Multiple documents were used as references to identify the points of contact used to gather the MC&G requirements data. Especially helpful was the *Marine Air-Ground Task Force: A Global Capability* [1], FMFRP 2-12, which described the Marine Air-Ground Task Force (MAGTF) and Marine Expeditionary Force. Their organizational structures and major Marine weapons/aircraft being used were also identified in [1]. A second document, *MAGTF C4I System Overview* [2], presented an overview of each system/program at the Marine Corps System Command [MARCORSYSCOM] (Marine Corps Tactical Systems Support Activity [MCTSSA]), Camp Pendleton, CA.

To determine Marine Corps current MC&G requirements, a questionnaire was developed and sent to each system/program manager at MARCORSYSCOM (MCTSSA) identified in the *MAGTF C4I System Overview*. Appendix A presents a copy of this questionnaire. A team of four NRL personnel spoke with each of the program managers at MARCORSYSCOM (MCTSSA) and followed up with in-person interviews to discuss their MC&G requirements and to collect the questionnaires. NRL completed two additional questionnaires from interviews conducted at MARCORSYSCOM: Expendable DRONE (EXDRONE) and Topographic Mapping Set (Topo Set). Finally, the Marine Corps Intelligence Activity provided input and clarification on some of the programs' use of MC&G.

The purpose of this questionnaire was two-fold: to gather information affecting MC&G requirements and to collect the data needed to populate the USMC planning factors database.

2.0 KEY MARCORSYSCOM (MCTSSA) PROGRAMS

The key MARCORSYSCOM (MCTSSA) programs using or planning to use digital MC&G (dMC&G) products are Air Defense Communications Platform (ADCP), Advanced Field Artillery Tactical Data System (MCFSS [AFATDS]), Advanced Tactical Air Command Center (ATACC), Data Automated Communications Terminal (DACT), Enhanced Position Location Reporting System (EPLRS), Expendable DRONE (EXDRONE), Improved Direct Air Support Central (IDASC), Intelligence Analysis System (IAS), Marine Combat Service Support Control System (MCSSC2), Nuclear, Biological, and Chemical Information, Hazard Warning System (NBC HazWarn), Position Location Reporting System (PLRS), Systems Planning Engineering Evaluation Device (SPEED), Technical Control and Analysis Center–Product Improvement Plan (TCAC-PIP), Tactical Combat Service Support Control System (TCO), Tactical Electronics Reconnaissance Processing and Evaluation System (TERPES), Topographic Mapping Set (Topo Set), and Tactical Remote Sensor System (TRSS). A summary of programs, program managers, divisions, and a short description of each program is provided in App. B.

2.1 Use of MC&G Data

There are 30 programs populating the requirements database. Two additional program questionnaires on Improved Direct Air Support Central (IDASC) and Tactical Air Operations Module (TAOM) were not received and only the information available from the *MAGTF C4I System Overview* has been included in the database.

Of the 30 programs included in the survey, 18 of 27 programs indicated use of MC&G data in either digital (14) or paper (5) form, currently or in the future. Three program questionnaires were incomplete (MAGTF Tactical Warfare Simulation (MTWS), EXDRONE, and Topo Set) in these areas. Those programs that reported using MC&G data are identified in Table 1 in the last two columns, dMC&G and Paper.

Table 2 shows current and future use of digital MC&G products listed by program and Defense Mapping Agency (DMA) product. This table shows the wide use of ARC Digitized Raster Graphics (ADRG) and Digital Terrain Elevation Data (DTED) over other DMA products. Table 3 shows the use of paper charts listed by program and chart type. The most commonly used paper charts are the Topographic Line Maps at 1:000,000 and 1:50,000 scales.

A total of 12 of the 28 program respondents indicated they did not use paper charts at all. Of these 12 programs, 3 reported using digital MC&G data products. A total of 8 program managers indicated that they do not use paper charts or digital data; their programs are in support of other USMC programs that are not concerned with MC&G data.

2.2 Connectivity

Table 4 shows the connectivity between MARCORSYSCOM (MCTSSA) programs, specifically which programs support others and which programs work in conjunction with others. Figures 1 through 6 visually show the same information centered around certain programs.

Table 1 — USMC MC&G Requirements Survey Points of Contact

Program	Title	Division	POC/Phone/DSN	dMC&G*	Paper*
ADCP	Air Defense Communications Platform	Air C2	1st Lt R. E. Lucius 619 725-2121, 365-2121	Y	Y
MCFSS [AFATDS]	Advanced Field Artillery Tactical Data System	GISD	Maj Stanley Watkins 628 725-2493, 365-2493	Y	Y
AN/MSC-63A	Communications Central	COMM/NAV	Jacqueline Sacheli 619 725-9513, 365-9513	N	N
ATACC	Advanced Tactical Air Command Center	Air C2	Ms. Chonie Jascheck 619 725-2907, 278-2907	Y	Y
ATHS II	Automatic Target Handoff System II	COMM/NAV	Chris Burkhardt 619 725-2852, 365-2852	N	N
DACT	Data Automated Communications Terminal	COMM/NAV	Chris Burkhardt 619 725-2852, 365-2852	Y	Y
EPLRS	Enhanced Position Location Reporting System	COMM/NAV	Lee Purrier 628 725-2354, 365-2354	Y	N
EXDRONE	Expendable DRONE	MARCORSYSCOM	Capt John Holmberg 619 830-5691	I	Y
HAWK	HAWK Missile System	Air C2	1st Lt R. E. Lucius 619 725-2121, 365-2121	N	Y
IDASC	Improved Direct Air Support Central	Air C2	Capt Pat Coronado 619 725-2132, 365-2132		
IAS	Intelligence Analysis System	GISD	Capt Mark Kalmbach, K. K. Knauth 628 725-2538, 365-2538	Y	Y
IFAS	Initial Fire Support Automated System	GISD	Maj Stanley Watkins 628 725-2493, 365-2493	N	Y
JINTACCS	Joint Interoperability of Tactical Command and Control Systems	Air C2	Sylvia Zoretic 619 725-2135, 365-2135	N	N

*Y = Yes, N = No, P = Phone Interview, I = Incomplete

Table 1 — Continued

Program	Title	Division	POC/Phone/DSN	dMC&G*	Paper*
JTIDS	JTIDS Module AN/TSC-131	Air C2	Peter Almazan 619 725-2412, 365-2412	N	N
LAV-AD	Light Armored Vehicle Air Defense Variant	Air C2	1st Lt R. E. Lucius 619 725-2121, 365-2121	N	Y
MTWS	MAGTF Tactical Warfare Simulation	GISD	E. C. Clark 628 725-2465, 365-2465	1	N
MCSSC2	Marine Combat Service Support Control System	GISD	Lt Paul Sullivan 628 725-9609, 365-9609	Y	Y
NBC HazWarn	Nuclear, Biological, and Chemical Information, Hazard Warning System	GISD	Thom Perfetto 628 725-2804, 365-2804	Y	Y
PLRS	Position Location Reporting System	COMM/NAV	Lee Purrier 628 725-2354, 365-2354	Y	N
SIE	Systems Integration Environment	SIE	Maj Cadwallader 628 725-2723, 365-2723	N	N
SPEED	Systems Planning Engineering Evaluation Device	COMM/NAV	Ken Wilson 628 725-2655, 365-2655	Y	N
TAOM	Tactical Air Operations Module	Air C2	Peggy Groneman 619 725-2288, 365-2288		
TCAC-PIP	Technical Control and Analysis Center Product Improvement Plan	GISD	Suzanne Schwab 628 725-2508, 365-2508	Y	Y
TCO	Tactical Combat Service Support Control System	GISD	Carlos Persichetti 628 725-2148, 365-2148	Y	Y
TERPES	Tactical Electronics Reconnaissance Processing and Evaluation System	NAWC UPNS Div	Sgt Schubert 628 725-2093, 365-2093	Y	Y
TDN	Tactical Data Network	COMM/NAV	Linda Collier 628 725-2085, 365-2085	N	N

* Y = Yes, N = No, P = Phone Interview, I = Incomplete

Table 1 — Continued

Program	Title	Division	POC/Phone/DSN	dMC&G *	Paper*
Topo Set	Topographic Mapping Set	MARCORSYSCOM	CWO Clay Brown 619 725-2582, 278-2582	Y	I
TPS-59	AN/TPS-59 Radar Set	Air C2	Paul Wong 619 725-2815, 365-2815	N	N
TRSS	Tactical Remote Sensor System	GISD	Waddy Stephenson 628 725-2509, 365-2509	Y	Y
ULCS	Unit Level Circuit Switch	COMM/NAV	Linda Collier 628 725-2085, 365-2085	N	N

* Y = Yes, N = No, P = Phone Interview, I = Incomplete

Table 2 — Current and Future dMC&G Use by Product and System

Program	ADRG	CAC	CADRG	CIB	CMIB	DBDB 0.1	DCW	DNC/ Lit	DTED L1	DTED L2	DTOP	LAND SAT	PITD	SPOT	TTD	UVMAP	VITD	VLID	VMAP 0	VMAP 1	VMAP 2	WD BII	WMM	WVS	WVS- VPF
ATACC	✓								●																
ADCP	✓	✓					●		●																
DACT			✓																						
EPLRS								●																	
PLRS									●	●															
SPEED						●											✓								
MCFSS [AFATDS]	●										●	✓	✓						●	✓	✓	✓	✓	✓	
IAS	●			✓	●						●	✓	✓						●	●	●	●	●	●	
MCSSC2	✓							✓			✓	✓							●	●	●	●	●	●	
TCO	●			✓	●						●	✓	✓						●	●	●	●	●	●	
TRSS	●																		●	●	●	●	●	●	
TCAC	●										✓	✓							●	●	●	●	●	●	
NBC HazWarr	✓							✓											✓						
TERPES	●	●										●	●						●	●	●	●	●	●	●
TOPO SET	●		●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	
Totals	11	1	7	3	1	1	6	4	1	1	11	8	4	2	2	1	1	3	2	2	1	5	1	3	

● Current and implied future use

✓ Future use

Table 3 — Use of Paper Charts

Program	ONC (1:1,000K)	TPC (1:500K)	JOG (1:250K)	TLM (1:100K)	TLM (1:50K)	City Graphics (1:15K)	No Paper Charts
ADCP	✓	✓	✓				
MCFSS [AFATDS]					✓		
AN/MSC-63A							✓
ATACC				✓	✓		
ATHS II							✓
DACT					✓	✓	
EPLRS							✓
EXDRONE					✓		
HAWK		✓	✓		✓		
IAS	✓	✓	✓	✓	✓	✓	
IFLAS					✓		
JINTACCS							✓
JTIDS							✓
LAV-AD		✓	✓		✓		
MTWS							✓
MCSSC2	✓	✓				✓	
NBC HazWarn	✓	✓	✓	✓	✓	✓	
PLRS							✓
SIE							✓
SPEED							✓
TCAC	✓	✓	✓	✓	✓	✓	
TCO	✓	✓	✓	✓	✓	✓	
TDN							✓
TERPES	✓	✓	✓	✓	✓	✓	
TPS-59							✓
TRSS				✓	✓		
UCLS							✓
Totals	7	9	8	7	13	7	12

Table 4 — Digital MC&G Connectivity

Receives Support from	Program	Gives Support to	Works in Conjunction with
HAWK, AN/TPS-59	ADCP	HAWK, JTIDS	AVENGER, HAWK, TAOM, manportable stinger
	AFATDS		BCS, IFSAS, DCT, MDS, EPLRS, JSTARS, CTAPS
	AN/MSC-63A	IAS, TERPES, TCAC, AN/TYC-39, ATACC	
DASC, TAOC, MATCALS	ATACC	DASC, TAOC, MATCALS	DASC, TAOC, MATCALS
	ATHS II		DMS
AFATDS, TCO, PLRS	DACT	AFATDS, TCO, PLRS	other DACTs
	EPLRS	AFATDS, FAAD	
TAOM	HAWK	TAOM	
TCO, AFATDS, MCSSC2, ATACC, TERPES, JDISS	IAS	TCO, AFATDS, MCSSC2, ATACC, TERPES, JDISS	TACFIRE, LTACFIRE, FIREFINDER BCS, MDS, DCT
	IFLAS		
TCO, MAFATDS, MACCS, IAS	MCASS	TCO, MAFATDS, MACCS, IAS	TCO, MAFATDS, MACCS, IAS
TCO, AS, AFATDS, ATACC/IDASC	MCSSC2	TCO, AS, AFATDS, ATACC/IDASC	TCIM
	MTWS		PLRS, TCO, IAS
GPS	PLRS	AN/KSQ-1, AADS, TCO, DAS	GPS
	SPEED	ULCS, PLRS	ULCS, PLRS
TPS, PACLESS, TRE, AN/MSC-63A, MEWSS	TCAC	IAS	
EA-6B Prowler, TRE	TERPES	IAS, TEAMS, TAMPs, NTCSA	Atlantic Intel Ctr for MIIDS IDB
IAS, TERPES, TCO, Field Officers, USA and USAF Topo Groups	TOPO SET		
	TPS-59	TAOM, ADCP	TAOM, ADCP
	TRSS	IAS	

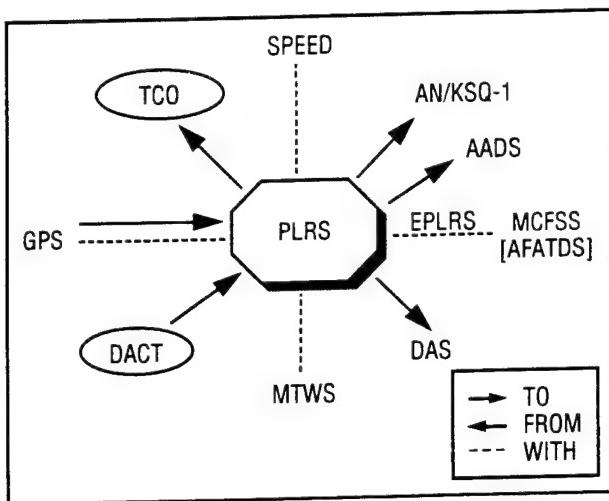


Fig. 1 -- PLRS connectivity

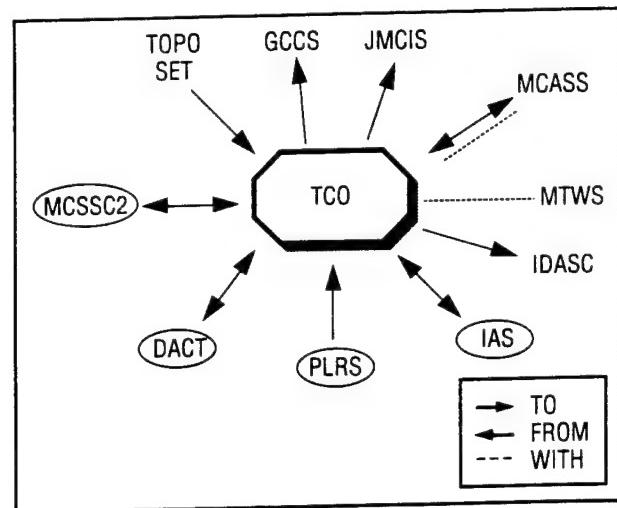


Fig. 2 — TCO connectivity

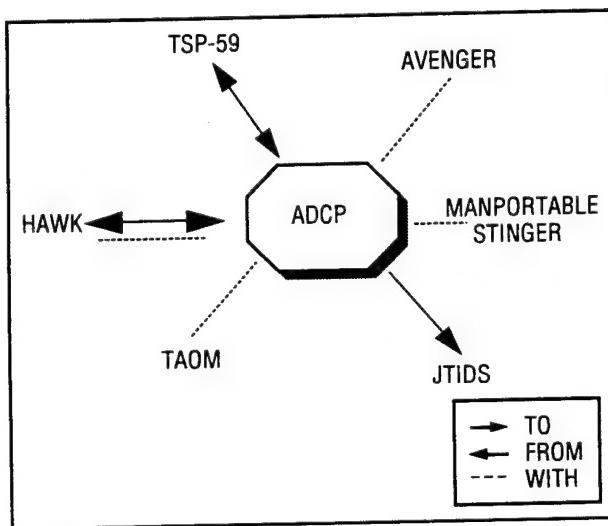


Fig. 3 — ADCP connectivity

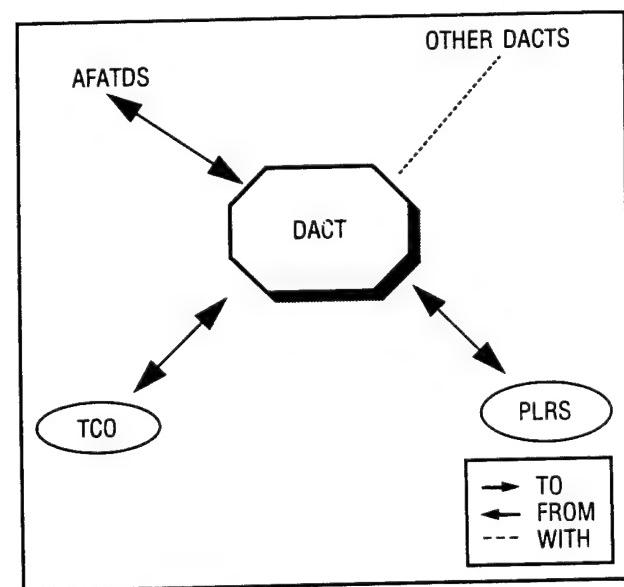


Fig. 4 — DACT connectivity

3.0 POTENTIAL AREAS FOR IMPROVEMENT

3.1 Requirements Not Met by Current dMC&G Products

3.1.1 Resolution

Ten DMA products were represented in the responses to the question relating to resolution requirements. Of these, five were cited with either a current or future resolution deficiency: ADRG, CADRG, DCW, DTED L1, and DTED L2 (Table 5). Five programs provided this information: ATACC, ADCP, DACT, EPLRS, and AFATDS. Additionally, a sixth program respondent, IFSAS, requested an overall improvement on vertical resolution since the 20-m contour interval is too coarse. However, the IFSAS respondent did not reference this statement to a particular product.

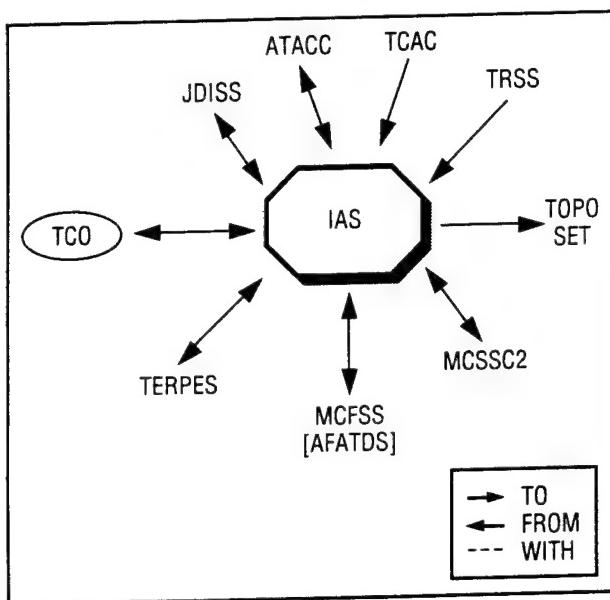


Fig. 5 — IAS connectivity

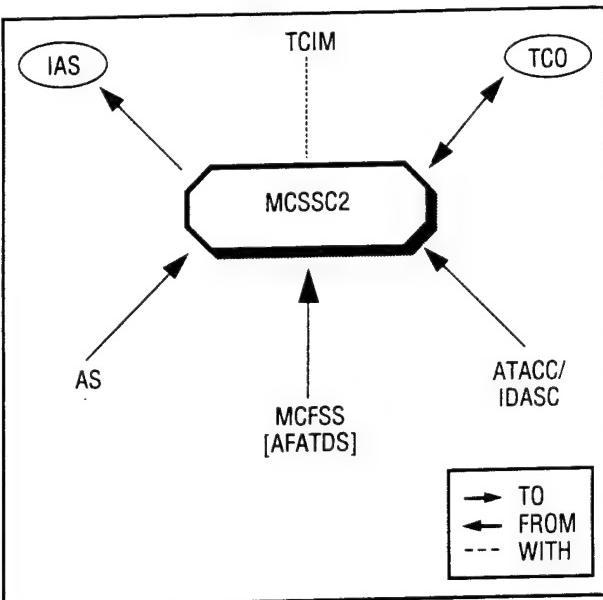


Fig. 6 — MCSSC2 connectivity

The five products currently meeting resolution requirements (and will continue to do so in the future) are Landsat, TTD, VMap 0, WDBII, and WVS.

Table 5 — Current and Future Resolution Deficiencies

Product	Current Deficiency	Future Deficiency
ADRG	ADCP	AFATDS
CADRG		DACT
DCW	ADCP	
DTED L1	ATACC, ADCP, EPLRS	
DTED L2		ADCP

Table 6 — Current and Future Accuracy Deficiencies

Product	Current Deficiency	Future Deficiency
ADRG	ADCP	AFATDS
CADRG		DACT
DCW	ADCP	
DTED L1	ADCP, EPLRS, PLRS	
DTED L2		ADCP

3.1.2 Accuracy

As in the case of resolution requirements, ten products were represented in the response to the question relating to accuracy requirements. The same five products (ADRG, CADRG, DCW, DTED L1, and DTED L2) were again cited with a deficiency, namely accuracy (Table 6). Five programs made the claim: ADCP, DACT, EPLRS, PLRS, and AFATDS. The five products with no accuracy deficiency (nor any anticipated accuracy deficiency) are also the same as in the resolution case: Landsat, TTD, VMap 0, WDBII, and WVS.

3.1.3 Area Coverage

With respect to lacking coverage, three questionnaires provided comments. SPEED has observed that DTED has missing coverage. TCAC needs a wider available coverage of City Graphics 1:15K. NBC HazWarn needs a larger scale, such as 1:50K full coverage.

3.1.4 Currency

The only comment relating to currentness of DMA products came from the AFATDS and IFSAS respondents: Update representation of man-made structures/features (road junctions, power lines, buildings, etc.).

In response to the question regarding MC&G data updates in the field ("Does this application require MC&G updates in the field?"), Table 7 shows the current (future) status.

3.1.5 Dimensionality

According to NBC HazWarn, future improvements to dMC&G should include three-dimensional development. PLRS, by its description, should also benefit from such advances.

3.2 Compression

Three products are currently being compressed (ADRG, DTED L1, and WDBII), with two additional products to be compressed in the future (DTED L2 and WVS) (Table 8). Table 8 also provides the program name and classification of compression (Y = lossY, L = lossLess). Of particular interest is the observation that only three programs are using compression, one of which uses a lossy technique.

Products that were specifically mentioned as not being compressed are DCW, Landsat, TTD, and VMap 0. In some cases, the information about compression was unknown. These programs are identified in Table 9.

Table 7 — Update Requirements and Source of Update

Product	DMA	Gov't Agency	Contractor	Updates Unavailable	No
ADRG	2 (1)	1	1 (1)		1 (2)
CADRG	(1)		(1)		
DCW	2		1		1
DG	1				
DTED L1	3 (1)	1	2		2 (1)
DTED L2	1 (3)		(1)		(1)
Landsat					(1)
MUSE		(1)			
TTD					(1)
VMAP 0	2				1
WDBII	2 (1)	1			
WVS	1 (1)	1			

Table 8 — Compression Requirements and Types of Compression

Product	Current	Future
ADRG	AFATDS (Y), TCAC (L)	
DTED L1	SPEED (L)	TCAC (L)
DTED L2		TCAC (L)
WDBII	TCAC (L)	
WVS		TCAC (L)

Table 9 — Programs with No Knowledge of Compression

Product	Current	Future
ADRG	ADCP, IAS, TERPES	ATACC
DCW	ADCP	SPEED
DTED L1	ATACC, ADCP, IAS, TCO, TERPES	
DTED L2	TERPES	ADCP, IAS, TCO
VMap 0		SPEED
WDBII	IAS	
WVS	IAS	

3.3 Examination of Paper Map Usage

The data in this survey indicates that the Topographic Line Map (1:50,000) is currently the most common hardcopy standard MC&G product being utilized by the USMC. The Tactical Pilotage Chart (TPC 1:500K) and Joint Operational Graphic (JOG 1:250K) represent the second and third most frequently used products. These maps present different levels of information useful to planning and operational aspects of the Marine Corps mission. Of the systems responding to the survey, the Advanced Field Artillery Tactical Decision System (AFATDS) indicated the broadest set of applications for paper products. The AFATDS supports the Combat Element (CE), the Ground Combat Element (GCE), and the Aviation Combat Element (ACE). Most users indicated only one or two significant mission areas and an equal number of combat elements for which hardcopy maps and charts are utilized. Table 3 indicates the systems reporting the use of paper products.

3.3.1 Use of Wrong Products

A common source of frustration and error associated with the use of paper MC&G products is the use of a product for applications other than those for which the product was designed. In some cases (e.g., exercise planning), this misuse can pose only minor inconveniences to the data user. In more critical applications (e.g., navigation), the use of the wrong product can produce deadly consequences. The information collected was not sufficient to identify specific misuse of paper

map and chart products. It is recommended that a more detailed investigation of these issues be conducted.

3.3.2 Lack of Use of Digital Products

Likewise, the effective use of digital products for mission planning and operational support requires a significant understanding of the intended application throughout the product design process. The increased usage of dMC&G data for USMC applications will depend directly upon the effectiveness of new and existing digital products to support mission-specific information tasks. Evaluation of existing dMC&G products in relation to USMC requirements is currently performed through Marine Corps tasking to NRL's DMAP group.

Proliferation of dMC&G information within the ranks of USMC is needed to encourage technical specialists to consider the use of dMC&G for their applications. Access to data and processing environments (e.g., GIS) must be facilitated at the Command level to ensure a strong proliferation of the technology within Marine Corps operations. DMAP assistance in the use of dMC&G data may also prove effective. The DMA's Defense Mapping School should also be examined as a resource for on-site short courses and training exercises to support the introduction of dMC&G directly into Marine applications.

3.3.3 Substitution of dMC&G Products for Paper Usage

The data reported within this survey were not sufficient to make significant examinations of overall paper product usage within the Marine Corps. However, the frequency and applications of those systems which are reported seem to indicate the majority of paper chart usage requires map data at smaller scales $\leq 1:50,000$. Of the 51 responses indicating a use of paper charts, only 20 were using a large-scale product with a map scale of $\geq 1:50,000$. It is suspected that more numerous large-scale applications of dMC&G information could be identified through an extended survey questionnaire.

3.3.4 Considerations for Analog-to-Digital Transition

The adaptation of dMC&G data products in the replacement of analog products does not always represent a one-for-one exchange. Since digital products can be integrated to support multiple applications, fewer digital products may be needed to replace or supplement the current usage of paper maps and chart products. However, in some cases, a replacement of the paper product may not be viable. Further examination of the usage of paper products in relationship to the individual applications and missions must be undertaken. Such a follow-on study should examine and contrast both the benefits and disadvantages of transition to dMC&G products. Since some mission applications preclude the use of digital equipment (e.g., remote terrain operations), significant examination must be made to determine which USMC applications currently utilizing paper maps and charts should transition to dMC&G data products.

The data contained within this study suggests two primary areas of benefit which might be gained by transition to dMC&G data: (1) horizontal and vertical datum control and (2) improvements in ability to examine worldwide applications.

The use of multiple datums for analog maps and charts often causes significant difficulties in the field. The nature of the Combat Chart suggests it was designed as a remedy for such problems. Topographic maps are based upon a mean sea-level vertical datum, while hydrographic charts are

most frequently based upon a vertical datum of mean low-low water. Thus, any cooperative use of these products must involve a transformation between these two datums. The use of dMC&G data allows for a much more rapid and consistent application of these transforms. Thus, applications could be given the flexibility of applying these transforms in a rapid and consistent manner. The use of dMC&G databases also allows for rapid shifts in the scale and resolution of data being displayed. Thus, a single integrated database may support both localized and worldwide applications for numerous users. Perhaps the most effective application of this capability is to support the decluttering of information displays to support tactical decision processes.

More specific information of Marine Corps requirements for dMC&G data should be collected to determine the overall effectiveness of this transition.

3.4 Equipment Hardware/Software Limitations

Of the projects using digital cartographic data, hard disk space is inadequate to gain full benefit. Of particular interest was the DACT (Digital Automated Communications Terminal) which is limited to a small hard drive, as well as limited to 16 shades of grayscale.

Limited storage capacity continues to be a problem with the use of the Vector Product Format (VPF) products because of the bulk of the data.

4.0 CONCLUSIONS

The Marine Corps is currently utilizing paper maps/charts as the primary MC&G source. However, multiple users noted the use of ADRG-type products with a likely strong demand (especially the 1:50K TLM and the City Graphics) for greater production of raster products in the near future. Some of the Marine Corps programs that participated in this study noted areas of potential improvement in their usage of MC&G. Specific recommendations are included in the next section.

Several Marine Corps program managers expressed a desire to learn more about DMA's suite of MC&G capabilities that may be exploited by their particular program. Areas for Marine Corps cost savings were identified, e.g., utilize DMA ADRG/CADRG instead of contractor-supplied scanned maps.

The Topo Set, a key Marine Corps program (as well as others) noted an immediate software requirement for software/tools to exploit VPF databases being produced by DMA. Currently, only VPFVIEW, MUSE, and Chart 2.0 (to a limited degree) support these databases.

The connectivity (which programs interact with others) of the surveyed programs is an important issue for understanding overall Marine Corps MC&G requirements. Initial connectivity diagrams were developed as a beginning point to better put into perspective various programs' MC&G requirements.

Most Marine Corps programs are very interested in the new developments in MC&G but will be very reliant on software development programs like the Global Command and Control System (GCCS) to bring advanced dMC&G capabilities to individual programs.

5.0 RECOMMENDATIONS

The following recommendations for improved Marine Corps usage of MC&G are provided based on the preceding discussion:

- TCAC-PIP should utilize CADRG for compressed ADRG instead of an individual compression of ADRG.
- ADCP and all Marine Corps programs should utilize ADRG/CADRG instead of contractor-generated scanned maps (if possible, given availability of ADRG/CADRG).
- Establish a software/hardware testbed to support key Marine Corps programs at NRL for improved product evaluations for Marine Corps.
- Request that DMA develop an "ADRG Field" specification which would allow users of ADRG in the field to rapidly scan an acquired map and disseminate with some degree of standardization, but not to include the full header requirements of ADRG.
- Provide additional briefing to Marine Corps Program managers on digital MC&G capabilities, especially on availability of ADRG/CADRG and TTD.
- Request DMA increase area coverage for City Graphics and 1:50K TLMs being scanned for ADRG.
- Provide programs with updates to DMA products from DMA and not contractors as is currently the case for a few programs.
- Advise programs to utilize WVS instead of WDBII (currently three programs utilize WDBII).
- Request DMA produce a standard compressed DTED and WVS product since Marine Corps programs are currently compressing these products.
- Perform a follow-on study focused on how paper maps/charts are functionally being used. This study would identify which Marine Corps program could quickly transition to digital products, and how they should make the transition. Also, the longer-term transitions would be identified, as well as programs that will likely never transition. This study could also further investigate multisource, multiresolution, and types of errors/conflicts that are possible with the use of multiple maps/charts, as well as a mixture of maps/charts and digital products.
- Request DMA include a standard symbology set for use with all VPF products. This set could be used in conjunction with the standard tactical symbology set.
- Place additional emphasis in the GCCS (Chart 2.0) arena to ensure a software package(s) is (are) developed soon that will allow Marine Corps exploitation of all VPF databases.

6.0 ACKNOWLEDGMENTS

This work was performed as part of the DMAP support to the Marine Corps Intelligence Activity. This project was managed by MAJ Bobby A. Mosley under program element 0301398. Technical review was provided by Ms. Maria Kalcic.

7.0 REFERENCES

1. Defense Mapping Agency, "MC&G Guidance Development," draft, DMAINST 8050.4, Enclosure (4), Fairfax, VA, 1993.
2. U.S. Marine Corps, "Marine Air-Ground Task Force: A Global Capability," FMFRP 2-12, Quantico, VA, April 10, 1991.

APPENDIX A

**U.S. MARINE CORPS
DIGITAL MAPPING, CHARTING, & GEODESY
REQUIREMENTS QUESTIONNAIRE
SUMMER 1994**



U. S. Marine Corps

Digital Mapping, Charting & Geodesy Requirements Questionnaire

Summer 1994

Conducted by the
Digital MC&G Analysis Program (DMAP)
Naval Research Laboratory Code 7441
Mapping, Charting, and Geodesy Branch
Stennis Space Center, MS 39529-5004

Please complete a separate questionnaire for each weapon system or program. Additional questionnaires can be obtained by calling Naval Research Laboratory, Susan Carter or Kevin Shaw at DSN 485-4652 or (601) 688-4652.

Security Note: If any answers to this questionnaire are classified, please mark appropriately and forward to NRL according to proper security regulations.

The purpose of this questionnaire is to (1) ensure Marine Corps requirements are included in the development of new DMA dMC&G products, (2) identify any immediate deficiencies, and (3) optimize Marine Corps usage of dMC&G. This survey is supported by the Marine Corps Intelligence Activity, Quantico, VA, MAJ Bob Mosley. The questionnaire is broken into five parts:

- Part I. Background
- Part II. MAGTF
- Part III. Weapon System/Program
- Part IV. Digital MC&G Data Use
 - Table 1. DMA Products
 - Table 2. Non-DMA Products
- Part V. Glossary and Short Summaries of DMA Products

Part I. Background

Your Name/Title:

Organization (Agency and Code):

Mailing Address:

Telephone: DSN:

<u>Technical Points of Contact</u>	<u>Name</u>	<u>Telephone</u>	<u>DSN</u>
MARCORSYSCOM	_____	_____	_____
Contractor	_____	_____	_____
MCTSSA	_____	_____	_____
Contractor	_____	_____	_____

Date questionnaire completed:

Part II. Marine Air-Ground Task Force (MAGTF)

1. What Marine Corps organizational level(s) does this program support?

- Command Element (CE)
- Surveillance, Reconnaissance, Intelligence Groups (SRIG)
- Ground Combat Element (GCE)
- Aviation Combat Element (ACE)
- Combat Service Support Element (CSSE)

2. What task force(s) does this program support?

- Marine Expeditionary Force (MEF)
- Marine Expeditionary Brigade (MEB)
 - Maritime Prepositioning Force (MPF)
 - Amphibious MEB (AMPMEB)
 - Norway airlanded MEB (NALM)
 - Air Contingency Force (ACF MEB)
 - Other (unique missions)
- Marine Expeditionary Unit (MEU)
- Special Operations Capable (SOC)

3. What is the normal operational area(s) of this program?

- I MEF (Camp Pendleton, CA; W. Pacific, SW Asia, Indian Ocean)
- II MEF (Camp Lejeune, NC; European, W. Africa, S.A. coastline)
- III MEF (Okinawa, Japan; E. Pacific)

Part III. Weapon System/Program

4. Identify the weapon system or program addressed in this questionnaire (acronym and full title):

Acronym:

Full Title:

5. Identify the primary agency for this system or program:

6. Give a brief description of this weapon system/program, or enclose existing documentation.

7. What is the current status of this weapon system or program? Please provide latest draft or signed documents.

Operational

Operational but undergoing an upgrade

Under development

Date of Tentative Operational Requirement (TOR)

Date of Developmental Options Paper (DOP)

Date of Operational Requirement (OR)

Funded

Entered in the POM Cycle (Year: _____)

8. List key milestones and dates in program development.

Date	Description
------	-------------

9. List connectivity with other weapon systems/programs:

a. to which your system/program provides input.

b. from which your system/program requires input.

c. used in conjunction with your system/program.

10. Does the program use an environmental sensor? Identify.

11. Is a new sensor needed for data collection? Identify.

12. a. Does this program involve modeling and simulation (M&S) efforts? _____
If so, please describe.

b. Will this program involve M&S efforts in the future? _____
If so, please describe.

13. Which of the following charts does your weapon system/program currently use?

- | | | |
|-------|-------------------------------------|-------------------|
| _____ | Operational Navigation Charts (ONC) | 1:1,000,000 scale |
| _____ | Tactical Pilotage Charts (TPC) | 1:500,000 |
| _____ | Joint Operations Graphic (JOG) | 1:250,000 |
| _____ | Topographic Line Map (TLM) | 1:100,000 |
| _____ | Topographic Line Map (TLM) | 1:50,000 |
| _____ | City Graphics | 1:15,000 |
| _____ | Other | _____ |

14. a. List any known shortcomings or suggestions for improvements for existing MC&G products that you are aware of.

b. List any ideas or new suggestions for new MC&G products.

15. Are you currently using any non-DMA provided digital data? _____
If so, please identify with the source and description of each data set.
(Also indicate on last page of Table 2.)

16. Are you aware of a paper map application that should be replaced by a digital MC&G
(computerized) product? _____
If so, please identify.

17. How can we make dMC&G better for your program?

Part IV. Digital MC&G Data Use

Please show your applicable responses for current and/or future use (e.g., C1, F1) under each digital product. If you are using a product that is not listed, please write it in at the end of the applicable table.

TABLE I. DMA PRODUCTS

TABLE 2. NON-DMA PRODUCTS	ADRI	AVHRR	DEM	DLG	HSDC	LANDSAT	SPOT
A. Please indicate awareness of DMA and Non-DMA products: 1 - Have full working knowledge 4 - Have never heard of 2 - Have heard of, but not used 5 - Other, please list. 3 - Will use in the future							
B. For those products currently in use or planned to be in use in the future, would increased training be beneficial for this product? 1 - Yes 2 - No							
C. For what type of application(s) are you using this product? 1 - Weapon System 5 - Command, Control & Commun. (C ³) 2 - Mission Planning 6 - Other operational purposes 3 - Training/Simulators 7 - Other non-operational purposes 4 - Navigation							
D. For which mission area(s) do you use this product? 1 - Joint Strike 5 - Strategic Deterrence 2 - Joint Littoral 6 - Strategic Sealift/Protection 3 - Joint Surveillance 7 - Training 4 - Joint SEWIC ¹							
E. For which warfare area(s) do you use this product? 1 - Anti-Air 8 - Electronic 2 - Anti-Submarine 9 - C ³ 3 - Anti-Surface ship 10 - Intelligence 4 - Strike 11 - Fleet Support 5 - Amphibious 12 - Construction 6 - Mine 13 - Anti-Combat 7 - Navy Special 14 - Other, please list							
F. What type of platform does this application reside on and how many of these platforms are in use (e.g., C1, 100)? 1 - AV-8B 6 - AH-1W 2 - F/A-18A/C 9 - CH-46E 3 - F/A-18D 10 - UH-1N 4 - A-6E 11 - KC-130 5 - EA-6B 12 - OV-10A/D 6 - CH-53A/D 13 - Other, please list 7 - CH-53E							
G. How would you classify this product? 1 - Mission critical 3 - Mission necessary 2 - Mission essential							
H. In what geographic areas do you use this product? 1 - U.S. and Canada 9 - Australia 2 - South America 10 - Arctic 3 - Central America 11 - Atlantic Ocean 4 - Europe 12 - Pacific Ocean 5 - Asia (excluding USSR) 13 - Indian Ocean 6 - USSR 14 - Mediterranean 7 - Persian Gulf Region 15 - Worldwide 8 - Africa 16 - Other, list specific area							
I. Are you currently compressing this product? 1 - Yes, using a lossy-type technique 3 - No 2 - Yes, using a lossless technique 4 - Not known							
J. Does this product require any modification before your application can use it? 1 - Yes, currently being performed by Gov't facility 2 - Yes, currently being performed by Contractor 3 - No							
K. How many other dMC&G products do you typically use with this digital product?							
L. Does this application require MC&G data updates in the field? 1 - Yes, updates by DMA 4 - Yes, Updates currently unavailable 2 - Yes, updates by Gov't agency 5 - No 3 - Yes, updates by Contractor							
M. Have you found any errors while working with this project? 1 - Yes 2 - No							
N. Is the product's current accuracy acceptable? 1 - Yes 2 - No							
O. Is the products current resolution acceptable? 1 - Yes 2 - No							
P - List the minimum number of initial issue copies required for the force to conduct operations (e.g., C1, 50) 1 - Unit Basic Load - sustain 10 days of operation 2 - Unit Mount-Out - sustain 30 days of operations 3 - Unit Marry-Up - >30 days, shortfalls							

Part V. Glossary of DMA Products

The following summaries are taken from *DMA List of Products and Services*, DMAL 805-1A, March 1994 unless otherwise noted.

AAFIF - Automatic Air Facilities Information File

A text file which contains evaluated information on aircraft movement surfaces (runways, taxiways, aprons, etc.), facilities, support equipment, services, operations, navaids/communications, transportation and other items for approximately 41,000 air facilities worldwide. Continental U.S. facilities are maintained with fewer subcategories due to availability of data from the Federal Aviation Administration.

ADRG - ARC (equal ARC second Raster Chart/map) Digitized Raster Graphics

ADRG are digital raster representations of paper graphic products. Maps/charts are converted into digital data by raster scanning and transforming the map image into the ARC system frame of reference. Data collected from a single chart/map series and scale will be maintained as a worldwide seamless database of raster graphic data with each pixel having a distinct geographic location.

ADRI - ARC Digital Raster Imagery

ADRI is digital imagery produced to support various Air Force weapons and mission support systems. ADRI is currently produced from panchromatic SPOT commercial imagery which is orthorectified using DMA DTED Level I or other elevation data to remove terrain displacement and other distortions which may be present within the original source imagery. A joint requirement has been recognized, and is being documented, for a broad-area Controlled Image Base (CIB). This initiative will replace anticipated follow-on developments with ADRI.

CAC - Compressed Aeronautical Chart

The CAC database is a processed form of ADRG that is produced by the U.S. Navy and distributed by DMA on CDROM optical disc. ADRG digital map images are converted from the ARC system frame of reference into the Tessellated Spheroid Model IV (TS) projection using a neighborhood averaging function. The TS data is then compressed in three stages: a color vector quantization process is used first, followed by a spatial classifier and a second vector quantization process. The final product is ADRG data that has been compressed by 48:1. Color palettes and spatial decompression code books are included with the image data for decompression and display. Data that has been collected and processed from a single chart series and scale are maintained as a worldwide, seamless database of raster graphic data with each pixel having a distinct geographic location.

CADRG - Compressed ARC Digitized Raster Graphics (Under Development)

CADRG is to be a jointly-coordinated common compression of ADRG for use in any application requiring rapid display of a map image or manipulation of the image of a map in raster form. CADRG achieves a nominal compression of 55:1 over ADRG.

CIB - Controlled Image Base (Under Development)

CIB is unclassified panchromatic (black and white) digital imagery produced to support a variety of mission planning and command, control, communications, and intelligence systems. CIB is a compressed and National Imagery Transmission Format Standard (NITFS) - compliant outgrowth of ADRI. CIB will initially be produced from SPOT commercial imagery that has been orthonormalized using DMA DTED1; it will eventually be produced from stereo imagery that has been orthorectified to remove relief displacements and other sources of positional error. DMA anticipates prototyping of CIB in early CY94 and beginning production later in the year.

CMIB - Controlled Multispectral Image Base (Under Development)

CMIB is unclassified multispectral digital imagery produced to support a variety of mission planning and command, control, communications, and intelligence systems. CMIB is a multispectral companion to CIB. CMIB will initially be produced from SPOT commercial imagery that has been orthonormalized using DMA DTED1; it will eventually be produced from stereo imagery that has been orthorectified to remove relief displacements and other sources of positional error. DMA anticipates prototyping of CMIB in mid CY94 and beginning production later in the year.

CRG - Compressed Raster Graphics (Under Development)

CRG is raster map image data derived for Army applications from DMA ADRG by a combination of spatial and color reduction. Spatial reduction is accomplished by averaging a two-by-two block of pixels into a single pixel for each of the 8-bit red, green, blue (RGB) components which results in a nominal spacing of 127 pixels per inch. The raster graphic image is then color-coded by mapping each 24-bit RGB pixel color to the closest value in predefined set of 16 colors to create a 4-bit data set. The entire process yields a net 24:1 compression ratio (4:1 spatially and 6:1 in color). CRG will be a legacy data set pending migration to CADRG or vector data sets.

DAFIF - Digital Aeronautical Flight Information File

A flight information database containing airport, runway, arresting gear, navigational aid, airways, waypoints, airspace, and terminal textual data covering the high and low altitude enroute structures.

DBDB - Digital Bathymetric Database

A gridded bathymetric database developed by the Naval Oceanographic Office. Depths are given in uncorrected meters for each 5 minutes of latitude and longitude worldwide. A classified (CONFIDENTIAL) version is also available covering the northern hemisphere.

DCW - Digital Chart of the World

The DCW is a 1700 megabyte database of vector geographic information. It provides global coverage of topographic information equivalent in detail to a 1:1,000,000 scale map. Furnished with DCW is application software along with its source code written in C language, designed to operate on MS-DOS based microcomputers. Each DCW data library contains 17 thematic layers. Application software, called VPFView, allows display of selected combinations of features and themes for a user-selected geographic area of interest. DCW is the first major dataset published in compliance with the Digital Geographic Information Exchange Standard (DIGEST).

DFAD - Digital Feature Analysis Data

Database consists of selected natural and manmade planimetric features classified as point, line, or area features as a function of their size and composition. Each feature is assigned an identification code and further described in terms of composition, height, length, and orientation. The data are stored in vector format and segregated into 1° by 1° geographic cells. DFAD Levels 1 and 2 are collected from photogrammetric source material. DFAD Level 1-C is collected from medium scale cartographic source material. DFAD Level 3-C is more detailed than DFAD Level 1-C. It is typically stored in variable patch sizes ranging from 2 x 2 nm to 10 x 10 nm.

DG - Digital Gazetteer (Under Development)

The Digital Gazetteer program is designed to provide DMA hardcopy gazetteer information in digital form. The data is structured as attributed points utilizing the VPF. The initial prototype dataset was provided with a commercial CDROM retrieval system; follow-on prototype data will be provided with DIGIGAZVIEW software. Production is expected to commence late FY94.

DLBD - Digital Landmass Blanking Data

Data in the form of a land/water matrix of elevation values, where a value of 200 meters is arbitrarily assigned to land and a value of 0 meters is assigned over water, to support airborne radar sensors operating in a maritime/coastal environment to filter out unwanted return from land and allow for better detection of ship and aircraft movement near the shoreline.

DNC - Digital Nautical Chart

DNC is a vector-based digital database containing selected maritime significant physical features collected from Harbor, Approach, Coastal and General charts in a format suitable for computerized marine navigation and Geographic Information Systems applications.

DPPDB - Digital Point Positioning Database

A deployable set of geodetically controlled imagery with associated parameters, indices and application software.

DSD - Digital Sailing Directions (Under Development)

The DSD is a two-year development effort designed to demonstrate, integrate, and prototype technologies supporting DMA's new Text Product Standard (TPS) concept. DMA is developing the TPS to support the production, distribution, and application of DMA publications in a digital environment.

A significant feature of the TPS is the use of Computer-aided Acquisition and Logistics Support (CALS) profile standards. The Standard Generalized Markup Language (SGML) will serve as the core standard for text formatting and tagging. The DSD prototypes will include an SGML-compliant dataset comprised of three volumes of DMA's Sailing Directions publications to demonstrate the capability for electronic interchange of digital text data using SGML.

In the initial DSD proof-of-concept prototype, the inclusion of embedded graphics and imagery will be implemented under Computer Graphics Metafile (CGM) and Tagged Image File Format (TIFF) profiles. Over time, the use of other CALS graphic standards, DMA's vector and raster product standards for map graphics, and DoD's NITFS will be implemented as appropriate to other individual textual prototype product specifications.

The DSD will be designed to provide an intelligent publication dataset with the capability to browse, query, and retrieve text and to demonstrate hypertext technology of SGML.

DTED - Digital Terrain Elevation Data

A uniform matrix of terrain elevation values. DTED provides basic quantitative data for all military systems that require terrain elevation, slope, and/or surface roughness information. Level 1 post spacing is 3 arc seconds (approximately 100 meters). Level 2 post spacing is 1 arc second (approximately 30 meters).

DTOP - Digital Topographic Data (Under Development)

The DTOP is being designed as a component of the future standard Tactical Terrain Data (TTD) land combat data set. DTOP consists of thematic layers from both terrain analysis and topographic line map products. The prototype data set is being produced, as part of a TTD prototype, to define the best method to meet the requirement.

ECHUM - Electronic Chart Updating Manual (Under Development)

The DMA Aeronautical Chart Updating Manual (CHUM) is a semi-annual (March and September) hardcopy publication containing a complete list of published charts for each chart series selected and a list of known corrections, if any, to each chart. A CHUM Supplement is published monthly during the five months between issues of the complete CHUM and contains a cumulative listing of additional corrections since the previous CHUM was published. The Electronic CHUM (ECHUM) will contain the same information as the CHUM but the information will be accessible from a magnetic tape, CDROM or other media. Under development.

FLIP - Flight Information Publications

Provides aeronautical information required by aircrews in flight and is designed for worldwide use in conjunction with the Enroute Supplements.

ITD/PITD - Interim Terrain Data/Planning Interim Terrain Data (Under Development)

The ITD is designed to provide digital terrain analysis data for systems being fielded prior to DMA production of Tactical Terrain Data beginning in FY96. It consists of contiguous digital data sets covering specified geographic areas. These data sets are composed of attributed and unsymbolized feature information equivalent to the content of either Tactical Terrain Analysis Databases (TTADBs) or Planning Terrain Analysis Databases (PTADBs) with an enhanced transportation file. ITD can be used in conjunction with DTED, ADRG base maps, and Video Laser Disc base maps.

ITD on CDROM is being developed to satisfy Service requirements for a terrain analysis data set that is machine readable and provided on a compact and stable storage media, and has been updated to conform to VPF.

MSDDB - Master Seafloor Digital Database (Under Development)

The MSDDB is a new distributed database being developed through the Defense Hydrographic Initiative. MSDDB will be a multilayered database composed of spatially coincident, georeferences, attributed, and deconflicted data describing the seafloor and water column. Proposed data layers include bathymetry, acoustic imagery, bottom roughness, slope and type, sub-bottom feature, navigational aids and hazard, geomagnetics, and gravity. MSDDB

is not a product but rather an integral part of DMA's Global Geospatial Information System. Plans are not finalized as to how MSDDB will be populated and maintained or how products will be extracted.

MUSE - MC&G Utility Software Environment (Under Development)
(summary not available)

NAVINFONET - Navigation Information Network

A special service to mariners providing remote access to extensive files of maritime safety information. It can be queried from anywhere in the world via modem communications equipment of a 24-hour basis. It supports and supplements the following navigational publications: Notice to Mariners, Summary of Corrections, List of Lights, U.S. Coast Guard Light List (except Volume 5), and DMA Catalog, Part 2 - Hydrographic Products.

PPDB - Point Positioning Database
(summary not available)

PVOD - Probabilistic Vertical Obstruction Data

A file which combines Residual Density Functions with discrete (manmade and natural) vertical obstruction data extracted from Vertical Obstruction Data (VOD), DFAD, the DMA Digital Vertical Obstruction File (DVOF), Power Line Data, Digital Cities Data, and Intelligence databases. VOD is a data file containing discrete position and height information of manmade objects and vegetation extending above the terrain. Vertical obstructions include such manmade objects as radio towers, smokestacks, bridges, powerlines, and other objects above minimum elevations specified by cruise missile planners.

TERCOM - Terrain Contour Matching Maps

Database derived from photogrammetric sources consisting of rectangular arrays of digital terrain elevation data at predetermined intervals, sizes, and orientations. The data are in matrix format, consisting of up to three reference maps composed of found elevation posts of various spacings depending on the size and type of matrix and required positional accuracy. The TERCOM maps, from largest to smallest matrix and post spacing, are the Landfall, Enroute, Midcourse, and Terminal Maps.

TTD - Tactical Terrain Data (Under Development)

TTD is DoD's future standard land combat data set. TTD will provide terrain information that is critical to planning and executing joint operations including close air support missions, amphibious operations, and land combat operations. TTD will support such diverse tasks as terrain visualization, mobility/countermobility planning, site/route selection, reconnaissance planning, communications planning, navigation, and munitions guidance. Implementation of TTD as a multi-product design or as an integrated geopackaged dataset will depend on prototype evaluations and assessment of production and maintenance concepts.

UVMap - Urban VMap (Under Development)

The UVMap program is designed to provide vector-based geospatial data with city graphic content. Data are separated into 10 thematic layers consistent throughout the VMap program. Each layer contains thematically consistent data. A reference library is provided with general information to orient the user. All data are topologically structured. Each coverage contains a set of files that describe the features in that thematic layer. Depending on data density, a UVMap library could be subtiled. When tiling is used, cross-tile topology is maintained. Prototype data are provided with VPFView software and symbology sets.

VLD - MC&G Video Laser Disc

The MC&G video disc consists of various scale maps and charts stored on a standard analog VLD. It provides the ability to quickly access and retrieve a wide variety of map and chart images. The system is designed to operate with a pc-compatible computer, two monitors, a video laser disc player, mouse, database software, and indexing system software.

VMap - Vector Smart Map (Under Development)

The VMap database is designed to provide vector-based geospatial data at low, medium, and high (Levels 0, 1, and 2 respectively) resolutions. Data are separated into 10 thematic layers consistent throughout the VMap program. Each layer contains thematically consistent data. A reference library is provided with general information to orient the user. All data are topologically structured. Each coverage contains a set of files that describe the features in that thematic layer. Data volume is tiled at nominal 5, 1, and 15 degrees (respectively) expanding in size toward the poles. Cross-tile topology is maintained. Initial content of this database is similar to that found in the DCW augmented with low resolution bathymetry for global coverage. Pre-production data is available and provided with VPFView software and symbology sets.

VPPDB - Video Point Positioning Database

Developed in response to user requests for a fast, portable, state-of-the-art, precise point positioning capability. Uses a personal computer and analog videodisc technology to allow real time coordinate readout. Designed for ease of use and minimal training time.¹

WMED - World Mean Elevation Data

A base of minimum, maximum, and mean terrain elevations. Elevation data (in meters) are collected for those world area grid (WAG) cells that are interior to a continent or island. A WAG cell covering less than 50 percent ocean surface is considered interior to the landmass. The preferred source is DTED. In areas with no DTED coverage, the best medium or small scale cartographic source is used. As additional DTED coverage is produced, updated WMED will be generated and made available to users on a quarterly basis.¹

WMM - World Magnetic Model

The WMM is a spherical harmonic model of the earth's main magnetic field and its secular change. The main field portion is to degree and order 12 and consists of 168 Schmidt-normalized spherical harmonic coefficients. The secular change field is also specified to degree and order 12 and consists also of 168 coefficients. Currently, however, the coefficients above degree 8 of the secular variation model are set to zero. This is due to the lack of data to generate this portion of the model. The WMM represents approximately 95% of the earth's magnetic field. The model is updated a 5-year intervals (1990, 1995, 2000, etc.) and is referred to is epoch date (e.g., WMM-90, WMM-95, etc.). Included with WMM is a computer software subroutine (GEOMAG) which uses the WMM to compute the earth's magnetic declination (D), inclination (I), total magnetic intensity (F), and grid variation (G) at any geographic position around the world at any depth/altitude between -100 km/+1000 km relative to sea level and at any time during the 5-year lifetime of the model.

WVS - World Vector Shoreline

The WVS is a digital data file containing the shorelines, international boundaries, and country names of the world. These geographic features are required for many of the digital databases being used to support geographic information systems and weapons systems. The WVS is a standard DMA product that has been designed for use in many different applications. An improved WVS implementing the Vector Product Format (VPF) is in development for distribution on CDROM.

WVS-VPF - World Vector Shoreline - Vector Product Format

The WVS database is being restructured into the VPF for distribution on CDROM. The coastal shoreline feature is derived from DLDB data, supplemented by Operational Navigation Charts (ONC) and Tactical Pilotage Charts (TPC). Other features are derived from the DBDB and the Joint Operations Graphic, ONC, and TPC paper products. Offshore territorial boundaries are derived from baselines found in DoD 2005.1M, the Maritime Claims Reference Manual.

¹ *Digitizing the Future*, DMA Stock No. DDIPDIGITALPAC, Third Ed.

APPENDIX B

**U.S. MARINE CORPS
PROGRAM TITLES AND DESCRIPTIONS**

Program	Title	Description
ADCP	Air Defense Communications Platform	The ADCP will provide a communications interface between the HAWK Battery Command Post (BCP) and a variety of surveillance platforms via data links. The primary mission of the ADCP will be to receive Tactical Ballistic Missile (TBM) cueing data from the AN/TPS-59 long-range surveillance radar, and relay targeting information to the HAWK missile system. The ADCP will also process numerous other data sources (TADIL A, ATDL-1, TADIL B, IBDL) for transmission to SHORAD units. The ADCP will provide a means to more fully integrate SHORAD elements (STINGER, AVENGER, and LAV-AD) into the C2 structure of the Marine Integrated Air Defense System (IADS). The ADCP will also provide a much needed, limited TBM defense capability to the MAGTF.
MCFSS [AFATDS]	Advanced Field Artillery Tactical Data System	A multiservice (Army-USMC) program designed to assist in the planning, supply, delivery, and coordination of supporting arms fire (artillery, mortars, naval gunfire, and air support). AFATDS systems will be fielded from Corps down to firing platoon level. The Marine Corps plans to replace IFASA with AFATDS (V2) in the FY98 timeframe.
AN/MSC-63A	Communications Central	The AN/MSC-63A system is a transportable ruggedized communications van that is capable of worldwide deployment via air, sea, and ground transportation. It provides secure semi-automated data communications support for the processing and recording of Sensitive Compartmented Information and General Services record message traffic to the commander of a deployed MAGTF.
ATACC	Advanced Tactical Air Command Center	The ATACC (AN/TYQ-51) provides an automated replacement for the current Tactical Air Command Central (TACC) (AN/TYQ1 and AN/TYQ3A). The mission of the TACC is to provide the facility from which the Tactical Air Commander (TAC) and the Aviation Combat Element (ACE) staff can supervise, coordinate, and execute current and future tactical air operations. In a joint environment this includes coordination of organic aviation with other services.

Program	Title	Description
ATHS II	Automatic Target Handoff System II	The AV-8B ATHS II is a digital communications device which utilizes preformatted messages to communicate with the Marine Corps' Digital Message System (DMS), AN/FSC-2A. It provides the ability to transfer targeting data, in milliseconds, directly to the aircraft mission computer from a FAC's DMS. The ATHS II Air Support Application (prototype) software program will serve as the interface between a Marine FAC using a DMS and the ATHS II equipped AV-8B aircraft.
DACT	Data Automated Communications Terminal	The DACT is a lightweight, hand-held communications device to be operated in the battlefield environment. DACT is designed to transmit and receive tactical information in broadcast mode and to provide navigational information to its user. Mapping capability of DACT will provide the user with capabilities to maintain map database, to display a map, and to generate an overlay. The DACT will be identified as a Marine Command Hardware Suite Class "D" terminal.
EPLRS	Enhanced Position Location Reporting System	EPLRS provides situational awareness that helps avoid fratricide and improves the Commander's C2 capabilities. With its automatic relay and distributed routing capability, EPLRS data distribution will be the principle communications means to link all five Battlefield Functional Areas with digital communications. The EPLRS is a computer-controlled, digital communications network for use by US Army troops and commanders on the battlefield.
EXDRONE	Expendable DRONE	This is a small DRONE aircraft that is flown ahead for reconnaissance purposes. DRONE is equipped with GPS for position.
HAWK	HAWK Missile System	The HAWK surface-to-air missile system provides medium-range, low-to medium-altitude air defense against a variety of targets, including jet and rotary wing aircraft, unmanned aerial vehicles, and cruise missiles. Future developments will provide an engagement capability against Tactical Ballistic Missiles (TBM). Since initial fielding in 1960, the HAWK system has been undergoing extensive redesign and modification to allow it to become a highly mobile, reliable, and effective weapons platform ideally suited to provide air defense for MAGTF.

Program	Title	Description
IDASC	Improved Direct Air Support Central	The DASC is the primary air control agency in the Marine Air C2 System responsible for the processing of direct air support requests. The DASC coordinates all air support, deconflicts aircraft with other supporting arms, and controls all aircraft operating in the designated airspace. The IDASC project is a Product Improvement Program (PIP) to an already fielded TSQ-155. It is being conducted in three major Phases. Phase 1 was electro-mechanical upgrades to the TSQ-155. Phase 2 is the downsizing of the shelters to make a more mobile, modular flexible DASC. This phase is the High Mobility Down-sized (HMD) DASC. Phase 3 will be the automation of selective DASC functions.
IAS	Intelligence Analysis System	The purpose of the IAS is to automate the MAGTF intelligence activities of direction, collection, processing, production, and dissemination of critical tactical intelligence from embedded databases and multiple sources. Interoperability with other systems such as Navy Tactical Command System-Afloat, Joint Deployable Intelligence Support System, and all Marine Air-Ground Intelligence Systems is maintained to ensure a common intelligence picture of the battlefield. The IAS also provides administrative support through the use of word processing, graphics, spreadsheet, and database management programs.
IFSSAS	Initial Fire Support Automated System	A multiservice (Army-USMC) program designed to assist in the planning, delivery, and coordination of most fire support assets (artillery, mortars, naval gunfire). IFSSAS is currently being fielded from the Corps down to the firing platoon level. The Marine Corps plans to replace this system with AFATDS in the FY98 timeframe.

Program	Title	Description
JINTACCS	Joint Interoperability of Tactical Command and Control Systems	<p>Today the demands of modern tactical warfare require the use of joint (multiservice) or combined (multinational) forces to maximize mission success. Joint task force operations highlight the importance of C2 because of the diversity of players involved and the critical need for these players to work together effectively under the umbrella of a central commander. The commander uses C2I systems to collectively manage overall employment of his military combat resources. To be effective and thus ensure success on the battlefield, these systems must be interoperable. The JINTACCS program was directed by the Joint Chiefs of Staff to ensure interoperability among joint and combined tactical C2I systems. JINTACCS is a team effort, with players from the Army, Navy, Air Force, Marine Corps, National Security Agency, Defense Information Systems Agency, and unified and specified commands. These program participants are the ultimate users of JINTACCS products.</p>
JTIDS	JTIDS Module AN/TSC-131	<p>The JTIDS Module (JM) is a standard 5-788 shelter that will be secured to and transported by an M1097 High Mobility Multipurpose Wheeled Vehicle, Huey Variant. The JM is used by the Marine Air Control Squadron in conjunction with the TAOM to provide JTIDS capability to the TAOC. The JM will be transportable by rail, ship, truck, aircraft, and as an external load to helicopters.</p>
LAV-AD	Light Armored Vehicle Air Defense Variant	<p>The LAV-AD will provide low-altitude air defense for the LAI Battalion and other rapidly maneuvering forces of the Ground Combat Element in coordination with other MAGTF air defense assets.</p>
MCSSC2	Marine Combat Service Support Control System	<p>The MCSSC2 provides the MAGTF commander, subordinate commanders, and staffs with an automated means of determining medical, personnel, and logistics status to facilitate the decision-making process. It is an integrated component of the Marine Tactical Command and Control System (MTACCS).</p>
MTWS	MAGTF Tactical Warfare Simulation	<p>The MTWS system is designed to provide exercise control services and tactical combat simulation to support preparation for and conduct of tactical exercises. The system will support both command post and field exercises involving actual combat units. MTWS system capabilities will cover the full range of MAGTF combat operations, including amphibious assaults, and will permit the widest spectrum of tactical conditions to challenge staff decision-making.</p>

Program	Title	Description
NBC HazWarn	Nuclear, Biological, and Chemical Information, Hazard Warning System	NBC HAZWARN system software provides an integrated automated information processing and warning system which gives the Marines the ability to respond to an NBC attack in a much more timely manner than is currently used. During peacetime, the system will be used to predict downwind hazards associated with hazardous chemical accidents of an industrial nature in and around Marine Corps bases and air stations.
PLRS	Position Location Reporting System	PLRS provides the Army Division and the MAGTF with timely and accurate 3-D positioning information in support of fast-moving tactical operations.
SIE	Systems Integration Environment	The SIE will provide a continuously accessible C4I infrastructure from which to conduct integration and interoperability assessments and FMF user appraisals of emerging communications and tactical data systems (TDS). The SIE is designed to represent the C4I system of a typical MAGTF with nodes for the CE, GCE, ACE, and CSSE. These nodes will be connected via standard Marine Corps communication assets, including Local Area Networks, with links to the Marine Corps Data Network and the Defense Information System Network (DISN) through the Joint Interoperability Test Center (JITC) at Ft. Huachuca, Arizona. Using the MAGTF model, the four nodes will be housed in Marine Corps Expeditionary Shelter System (MCNESS) shelters aboard the MCTSSA compound. The shelter system allows the SIE to emulate the look and feel of FMF Field Command Elements. TDSs are connected in the SIE using ULCS, LAN/WAN, and single and multichannel radio.
SPEED	Systems Planning Engineering Evaluation Device	Communication planning tool that provides path propagation analyses for radio spectrum HP -> SHF frequencies. Helps engineer radio links in the field. Other modules included with SPEED help in designing switched telephone/data networks (TNAPS+, SNAP) and RBECS, the program that allows SINCGARS radios to frequency hop.

Program	Title	Description
TAOM	Tactical Air Operations Module	The TAOM is used by the Marine Air Control Squadron to field the TAOC. With the TAOM, the TAOC provides the Marine Aviation Commander with the facilities to employ tactical aviation and Ground-Based Air Defense (GBAD) coordination in support of the Ground Combat Forces. The TAOM provides fully automatic air defense capability which can be easily deployed and is readily expandable due to its modular design. It is a transportable, modularized, software intensive, automated C2 system which operates in realtime to provide air defense and airspace management encompassing the full spectrum of tactical air operations. C2 interoperability in the tactical arena is now achievable worldwide through TAOM employment.
TCAC-PIP	Technical Control and Analysis Center Product Improvement Plan	The TCAC is the primary tool utilized by a Radio Battalion Operations Collection and Analysis Center (OCAC) to perform analysis of SIGINT data and steer the SIGINT collection assets of the Radio Battalion. It is employed with all MAGTFs and utilized during all phases of battle. TCAC supports the Radio Battalion OCAC mission of providing the tactical commander with finished SIGINT information.
TCO	Tactical Combat Service Support Control System	TCO is a Fusion Center for the G300 and provides the common situation awareness throughout the battlefield. It encompasses both friendly and enemy position information.
TERPES	Tactical Electronics Reconnaissance Processing and Evaluation System	TERPES is designed to process, sort, analyze, display and correlate digital Electronic Support Measures (ESM) and Electronic Countermeasures (ECM) data collected by the EA-6B Improved Capability (ICAP)-II aircraft. A tactical air intelligence database is maintained and intelligence analysis support is provided to the ACE and the Command Element of a MAGTF to determine the nature of the enemy threat and to plan combined arms operations. The collected data is correlated with Tactical Receive Equipment and other source information, and provides a base of Electronic Intelligence for intelligence fusion, C2, and tactical mission planning systems.

Program	Title	Description
TDN	Tactical Data Network	The TDN will provide the Marine Corps with a complete, integrated data network, forming the communications backbone for the MAGTF. The TDN consists of two major components: The TDN gateway and the TDN server. The TDN gateway will provide access to the DISN, DSNET1, and other service tactical packet switched networks. The TDN capabilities will allow the Marine Corps to use the current DoD protocol standard and offer compatibility with other service's internet protocols until the full employment of GOSIP standards throughout DoD. The TDN system will give the Marine Corps tactical users the ability to transition from AUTODIN to its mandated replacement system, the Defense Message [®] System (DMS).
TopoSet	Topographic Mapping Set	Topo Set consists of 3 vans of computers and peripherals used to generate maps on the spot for the Marine Corps. Upgrade will be TPC (Topographic Prediction Capability). There is a portable component called DTAMs.
TPS-59	AN/TPS-59 Radar Set	The AN/TPS-59 Radar Set is a Marine Air C2 System which serves as the primary sensor for the MAGTF, providing air target information and raw video to the TAOM. It can also be forward-deployed as a stand-alone remote sensor and air traffic controller.
TRSS	Tactical Remote Sensor System	TRSS is made up of three functional elements: sensors, monitors, and relays. The sensor element is a suite of remote sensing devices that detects activity using seismic, magnetic, infrared, and imaging technologies; the monitor element contains equipment that displays sensor messages for interpretation by trained personnel; and the relay element is used to overcome line-of-sight and transmission range limitations.
ULCS	Unit Level Circuit Switch	The ULCS provides the circuit and data switching capabilities for the switched backbone portion of the USMC tactical communications architecture. The ULCS also acts as a gateway to the joint tactical and strategic networks. The ULCS is employed at command elements of the MAGTF, communications, battalions, communications squadrons, and communications companies.